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Specification

Title of Invention: PATTERN MANUFACTURING METHOD AND PATTERN MANUFACTURING APPARATUS

Abstract

[Objective]

A pattern manufacturing method is disclosed with eliminating defects of a resist pattern forming process in a lithography method.

[Aspect]

Fluid (11-1n) is manufactured by dissolving a resist material used as a solute in a solvent. This fluid is discharged from an ink jet system head (21-2n) over a pattern forming face (100).

[Scope of Claims]

[Claim 1] A pattern manufacturing method for forming a resist pattern over a pattern forming face, comprising the step of:

depositing droplets of fluid in which a resist material used as a solute is

dissolved in a solvent over the pattern forming face.

[Claim 2] The pattern manufacturing method according to claim 1, wherein the droplets of the fluid are deposited over the pattern forming face by being discharged from an ink jet system head.

[Claim 3] The pattern manufacturing method according to claim 1, wherein a concentration of the resist material in the fluid is varied corresponding to a required condition for the resist.

[Claim 4] The pattern manufacturing method according to claim 1, wherein a deposited quantity of the droplet per unit area over the pattern forming face is varied corresponding to a required condition for the resist.

[Claim 5] The pattern manufacturing method according to claim 4, wherein the deposited quantity of the droplet is controlled by a number of times of depositing over the droplets per unit area over the pattern forming face.

[Claim 6] The pattern manufacturing method according to claim 4, wherein the deposited quantity of the droplet is controlled by a pitch between droplets to be deposited over the pattern forming face.

[Claim 7] The pattern manufacturing method according to claim 4, wherein the deposited quantity of the droplet is controlled by a quantity of the droplet for one time depositing.

[Claim 8] The pattern manufacturing method according to claim 1, wherein viscosity of the fluid is adjusted to from 1 cp to 20 cp by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent.

[Claim 9] The pattern manufacturing method according to claim 1, wherein

viscosity of the fluid is adjusted to from 2 cp to 4 cp by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent.

[Claim 10] The pattern manufacturing method according to claim 1, wherein surface energy of the fluid is adjusted to from 20 mN/m to 70 mN/m by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent.

[Claim 11] The pattern manufacturing method according to claim 1, wherein surface energy of the fluid is adjusted to from 30 mN/m to 60 mN/m.

[Claim 12] The pattern manufacturing method according to claim 2, wherein a contact angle between the fluid and a material which constitutes the head nozzle face is adjusted to from 30° to 170° by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent.

[Claim 13] The pattern manufacturing method according to claim 2, wherein a contact angle between the fluid and a material which constitutes the head nozzle face is adjusted to from 35° to 65° by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent.

[Claim 14] The pattern manufacturing method according to any one of claims 8 to 13, wherein a concentration of a solute in the fluid is adjusted to from 0.01 wt% to 10 wt%.

[Claim 15] The pattern manufacturing method according to claim 1, wherein the solvent in the fluid is constituted by one or more solvent among glycerin, diethylene glycol, methanol, ethanol, water, 1, 3-dimethil-2-imidazolidinon (DMI), ethoxyethanol, N,N-dimethylformamide (DMF), N-methylpyrrolidone

(NMP), and ethylene glycol series ether.

[Claim 16] The pattern manufacturing method according to claim 1, wherein the resist material is any one of cinnamic acid vinyl, novolak series resin, polyimide, and epoxy series.

[Claim 17] The pattern manufacturing method according to claim 1, wherein a process for forming a resist pattern by solidifying the droplets which is deposited; and a process for etching the pattern forming face over which the resist pattern is formed; are further provided after a process for depositing droplets of the fluid.

[Claim 18] A pattern manufacturing apparatus for forming a resist pattern over a pattern forming face; comprising:

an ink jet system head which is constituted to be able to deposit droplets of fluid in which a resist material used as a solute is dissolved in a solvent over a pattern forming face;

a transferring device which is constituted to be able to vary a relative position of the ink jet system head and the pattern forming face; and

a control device for controlling discharge of the fluid from the ink jet system head and drive by the driving device;

wherein the control device is constituted to be able to form the resist pattern by making the ink jet system head move along an arbitrary pattern forming region by the transferring device while making the droplets of the fluid deposit over the pattern forming face from the ink jet system head.

[Claim 19] The pattern manufacturing apparatus according to claim 18,

wherein the ink jet system head is constituted to be able to discharge selectively the fluid having a resist material with different concentration, and the control device is constituted to be able to vary concentration of the fluid which is discharged by the ink jet system head corresponding to required conditions for resist.

[Claim 20] The pattern manufacturing apparatus according to claim 18, wherein the control device is constituted to be able to vary deposited quantity of fluid which is deposited over the pattern forming face corresponding to required conditions for resist.

[Claim 21] The pattern manufacturing apparatus according to claim 20, wherein the control device varies the deposited quantity of the fluid which is deposited over the pattern forming face by controlling a number of times of discharge of the droplets per unit area over the pattern forming face.

[Claim 22] The pattern manufacturing apparatus according to claim 20, wherein droplet discharging timing from the ink jet system head and transferring speed of the transferring device are controlled, so that the pitch between droplets deposited over the pattern forming face is varied and the droplets are deposited over the pattern forming face, and consequently the deposited quantity of the fluid is varied.

[Claim 23] The pattern manufacturing apparatus according to claim 20, wherein the ink jet system head is constituted to be able to vary the deposited quantity of the fluid discharged per one time, and the control device varies the deposited quantity of the fluid which is deposited over the pattern forming

face by controlling droplet quantity of the fluid discharged by the ink jet system head.

[Detailed Description of the Invention]

[Industrial Field of Application]

The present invention relates to pattern formation over a substrate, and more particularly to a pattern manufacturing technology for resolving demerits of a lithography method by using an ink jet system and the like.

[Related Art]

A lithography method and the like are conventionally used for manufacturing a minute circuit, for example an integrated circuit. For example, a basic treatment process of the lithography method is disclosed in pp283-293 of "Thin Film Handbook" edited by Japan Society for the Promotion of Science. According to this reference, for example, a photosensitive material called resist is coated thinly over a silicon wafer, and a photo mask corresponding to a circuit pattern which is formed by photoengraving is provided over the resist. Subsequently, the resist in the region over which is not shielded from light with the photo mask is exposed, and a developing treatment is carried out to provide the resist pattern corresponding to the circuit pattern over the silicon wafer. Then, the silicon is removed by etching via the resist pattern to form the silicon in accordance

with the pattern. According to the reference, a spinner method, a spray method, a roll coater method, and an immersion method have been used to coat the resist. For example, according to the spinner method, a substrate is set on a rotating carriage and is coated with a resist material while the substrate is being rotated at high speed.

[Problems that the Invention is to Solve]

However, there were some inconveniences such as waste of resist material, increase of the number of processes, or limitation of the resist material in the resist forming processes which are generally used in a lithography method.

Namely in the conventional resist coating method, the resist material requires being coated over an entire surface over which a pattern is formed even if a region to be a resist pattern for etching is very small, further, it is difficult to control a film thickness of the resist. Particularly, in the coating method by spinner, there is a problem that the resist material which is leak out at coating goes round to the back side of a substrate as well as that 95 % of the material or more is wasted.

Further in the conventional resist pattern forming method, a good deal of process control and many processes are required until the resist pattern is obtained such as resist coating, masking, exposing, developing, or removal of needless resist. Moreover, a material besides the resist is required, for example, a negative film is required for a photo mask material. If the screen

print or a blade method is used, the waste of material is prevented to some extent, however, since it is unchanged that a thickness of resist is difficult to control, it is impossible to resolve the waste of a resist material fundamentally. Judging from these, it is unavoidable to waste a material and increase processes, which causes a steep rise in the manufacturing cost in the conventional method.

Furthermore, the resist conventionally requires being exposed, so that the resist is limited to a material having photosensitivity, and so the selection of the material is limited.

In view of the foregoing, the present applicant noticed that the inconveniences can be resolved entirely by using an ink jet system and the like, which turns the present applicant's thought to provide a new option for a pattern technology.

[Means for Solving the Problems]

Namely, a first object of the present invention is that it is designed to reduce the waste of resist material and the number of processes by a manufacturing method of providing resists locally, so that the manufacturing cost is reduced. A second object of the present invention is that it is designed to reduce the waste of resist material and the number of processes by providing a concrete selection option of adjusting a thickness of a resist, so that the manufacturing cost is reduced. A third object of the present invention is that the limitation that the resist should have photosensitivity is

removed by presenting conditions for providing resists locally, so that the selectivity of resist is improved. A fourth object of the present invention is that limitation that the resist should have photosensitivity is removed by presenting composition for providing resist locally, so that the selectivity of resist is improved. A fifth object of the present invention is that it is designed to reduce the waste of a resist material and the number of processes by offering a manufacturing apparatus for providing resist locally, so that the manufacturing cost is reduced.

The invention to achieve the first object is a pattern manufacturing method for forming a resist pattern over a pattern forming face, wherein a process for making droplets of fluid in which a resist material used as a solute is dissolved in a solvent deposit and solidification over the pattern forming face. In addition, when a resist is patterned to the predetermined position and the resist material has the etching-resistant, processes for exposure and development can be omitted.

"Fluid" means here a liquid having the viscosity which can be discharged from a nozzle of an ink jet system head. The solvent of "fluid" is irrespective of aqueous or oleaginous. Since it is enough that the fluid has the flowability (viscosity) to the extent that makes the fluid be able to be discharged from a nozzle and the like, it is allowed that microparticles of solid substances are dispersed as a resist material in the fluid. Also "pattern forming face" means a surface over which a pattern is deposited irrespective of being a plane surface, a curved one, or an uneven one, and a hard surface

like a substrate or a surface of a film having the flexibility.

It is preferable that droplets of fluid are deposited over the pattern forming face by being discharged from an ink jet system head in the above process. Namely, various methods such as various printing methods can be applied as a method for depositing the fluid, however the fluid can be made to deposit over an arbitrary place of the pattern forming face with an arbitrary thickness by low cost equipment due to the ink jet system. As the ink jet system, a piezojet system which discharges the fluid by volume change of a piezoelectric element, or a system which discharges the fluid by generating vapor immediately by thermal application can be used.

In the invention of resolving the third problem, as the conditions required for the fluid, the viscosity is required adjusting from 1 cp to 20 cp by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent. If the viscosity is lower than 1 cp, a quantity of solid content is too little, so that film formability becomes worse, and consequently the clogging frequency of a nozzle hole is increased in the case that the viscosity is higher than 20 cp since it is difficult to discharge smoothly. Furthermore, it is preferable that the viscosity is adjusted to from 2 cp to 4 cp, since the film formability is good and the clogging frequency of the nozzle hole is low within this range of the viscosity.

Surface energy of the droplets of the fluid is required adjusting from 20m N/m to 70 mN/m by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent. If the surface energy is lower than 20

mN/m, wettability on the periphery of the nozzle hole is increased, and deflection of a droplet is caused. If the surface energy is higher than 70 mN/m, a meniscus shape on the tip of the nozzle remains unstable, so that it is difficult to control the quantity and the timing of discharge. It is preferable that the surface energy is adjusted to from 30 mN/m to 60 mN/m.

The adhesion between the fluid and the pattern forming face are measured by a contact angle. The contact angle between the fluid and a material which constitutes the head nozzle face is required adjusting from 30° to 170° by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent. If the contact angle is smaller than 30°, wettability on the periphery of the nozzle hole is increased, and deflection of a droplet is caused. If the contact angle is wider than 170°, the meniscus shape on the tip of the nozzle remains unstable, so that it is difficult to control the quantity and the timing of discharge. Particularly, it is preferable that the contact angle between the fluid and a material which constitutes the head nozzle face is adjusted to from 35° to 65°.

It is preferable that a concentration of a solute in the fluid is adjusted to from 0.01 wt% to 10 wt%. The efficiency is low in the case that the concentration of the solute is lower than 0.01wt%, since a good deal of quantity of fluid is made to be discharged to form a resist layer with an enough thickness. If the concentration of the solute is higher than 10 wt%, viscosity of the fluid is so increased that it is difficult to discharge the fluid.

For example, in the invention of achieving the fourth object, a solvent

in the fluid is constituted by one or more solvents among glycerin, diethylene glycol, methanol, ethanol, water, 1,3-dimethil-2-imidazolidinon (DMI), ethoxyethanol, N,N-dimethylformamide (DMF), N-methylpyrrolidone (NMP), and ethylene glycol series ether. Mixture of these solvents can meet the conditions. Further, the resist material used as a solvent is any one of cinnamic acid vinyl, novolak series resin, polyimide, and epoxy series resin. Of course, as far as the conditions are met and the resistance to etchant at etching is satisfied, materials besides these ones can be used.

In the invention of achieving the second object, it is constituted to vary a concentration of the resist material in the fluid corresponding to the conditions required for the resist. Further, the deposit quantity of the droplet per unit area of the pattern forming face can be varied. Methods for varying the deposit quantity of the droplet are by controlling the number of times of deposit of the droplets per unit area over the pattern forming face, by controlling the pitch between the droplets to be discharged over the pattern forming face, or by controlling a quantity of a droplet deposited per one time.

In addition, after a process for depositing droplets of the fluid in the present invention, a process for forming a resist pattern by solidifying the deposited droplets and a process for etching the pattern forming face over which the resist pattern is formed are further provided. A substrate is patterned by performing these processes in conjunction with the resist coating of the present invention.

The invention of achieving the fifth object is a pattern manufacturing

apparatus for forming a resist pattern over a pattern forming face, and comprises the followings.

a) An ink jet system head which is constituted to be able to deposit droplets of the fluid in which a resist material used as a solute is dissolved in a solvent (irrespective of a piezojet system or an injecting system by cell).

b) A transferring device which is constituted to be able to vary the relative position of the ink jet system head and a pattern forming face (a step motor, a rotary motion-horizontal motion conversion mechanism, and the like).

c) A control device which controls discharge of the fluid from the ink jet system head and driving by a driving device (a computer, a sequencer and the like). This control device is constituted to be able to form a resist pattern by depositing droplets of the fluid from the ink jet system head over the pattern forming face, while shifting the ink jet system head along an arbitrary pattern forming region by the transferring device.

[Embodiment Mode]

Hereinafter, an embodiment mode of the present invention is explained with reference to the drawings.

(Explanation of Constitution) Fig. 1 shows a block diagram of a pattern manufacturing apparatus which is used in the present embodiment. The present pattern forming apparatus comprises ink jet system heads 21 to 2n (n is an arbitrary natural number), tanks 31 to 3n, a transferring device 4, and a control circuit 5.

Each fluid 11 to 1n is manufactured by dissolving a solute of a resist material in a solvent. The fluid 11 to 1n each is stored in the tanks 31 to 3n, and is supplied from the tanks to pressurizing chambers of the ink jet system heads when pressure in the pressurizing chambers of the ink jet system heads 21 to 2n are reduced.

As the conditions required for the fluid, viscosity is required adjusting from 1 cp to 20 cp by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent. If the viscosity is lower than 1 cp, a quantity of solid content of the fluid is too little, so that the film formability becomes worse, and consequently the frequency of clogging of a nozzle hole is increased in the case that the viscosity is higher than 20 cp since it is difficult to discharge smoothly. Furthermore, it is preferable that the viscosity is adjusted from 2 cp to 4 cp, since the film formability becomes good and the frequency of clogging of a nozzle hole is low within this range of the viscosity.

The droplets of the fluid of which surface energy is required adjusting from 20m N/m to 70 mN/m by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent. If the surface energy is lower than 20 mN/m, the wettability on the periphery of the nozzle hole is increased, and deflection of a droplet is caused. If the surface energy is higher than 70 mN/m, a meniscus shape on the tip of the nozzle is not stable, so that it is difficult to control the quantity and the timing of discharge. It is preferable that the surface energy is adjusted from 30 mN/m to 60 mN/m.

The adhesive properties of the fluid and a pattern forming face is measured by a contact angle. The contact angle for a pattern forming face is required adjusting from 30° to 170° by adjusting a concentration of a solute, a kind of a solvent, or a quantity of a solvent. If the contact angle is smaller than 30°, the wettability on the periphery of the nozzle hole is increased, and deflection of a droplet is caused. If the contact angle is wider than 170°, a meniscus shape on the tip of the nozzle is not stable, so that it is difficult to control the quantity and the timing of discharge. Particularly, it is preferable that the contact angle for the pattern forming face is adjusted from 35° to 65°.

It is preferable that a concentration of a solute in the fluid is adjusted from 0.01 wt% to 10 wt%. The efficiency is low in the case that the concentration of the solute is lower than 0.01wt%, since a large number of quantities of fluid is made to be discharged for forming a resist layer with an enough thickness. If the concentration of the solute is higher than 10 wt%, the viscosity is so increased that it is difficult to discharge the fluid.

Composition examples of resist materials (solutes) and solvents are shown in Table 1.

[Table 1]

Solute (resist material)	Solvent
any one of cinnamic acid vinyl, novolak resin, polyimide, and epoxy series resin	one or more solvents among glycerin, diethylene glycol, methanol, ethanol, water, 1,3-dimethil-2-imidazolidinon (DMI), ethoxyethanol, N,N-dimethylformamide (DMF), N-methylpyrrolidone (NMP), and ethylene glycol series ether

In Table 1, for example if the solute has etching-resistance, non-photosensitive polyimide is not required to have photosensitivity, therefore the non-photosensitive polyimide is possible to use, and has advantage of being fluid easily due to being possible to DMF. Further, the novolac series resin does not require a photosensitive group, so that it has advantages that solvents are selected widely as well as the composition cost is reduced. Due to the same reason, the cinnamic acid vinyl and the epoxy series resin are also effective.

Moreover, glycerin and diethylene glycol can be used for a lubricant. The physical properties value of the lubricant is adjusted by adding the solute, the solvent, the lubricant, water, methanol, a cellosolve series solvent, and cyclohexanone so that the lubricant fits the physical condition as the fluid. In addition, as far as meeting the above conditions and the resistance to etchant at etching, materials besides the above ones can be used as a solute, a solvent and a lubricant.

The ink jet system heads 21 to 2n respectively have the same constitutions. Any of the head is needed only to be constituted to be able to discharge the fluid by an ink jet system. Fluid 1x from a tank 3x (x is an arbitrary number of 1 to n) is supplied to an ink jet system head 2x one-on-one. The ink jet system head comprises, for example a piezojet system of on-demand type, a vibrating plate which is provided over one face of a substrate in a pressure chamber in which a plurality of pressurizing chambers are provided, and a piezoelectric element in which a piezoelectric

ceramic crystal is interposed between electrode films in the position corresponding to the pressurizing chamber of the vibrating plate. A nozzle plate over which a nozzle hole is provided is pasted to another face of the substrate in the pressure chamber. The fluid for improving the conductivity is supplied to the pressurizing chamber from the tank. Furthermore, when the volume change is caused to the piezoelectric element by supplying a discharging signal Sh from a control circuit 5 between the electrode films of the piezoelectric element, the pressure change is caused in the pressurizing chamber. When the pressure change is caused in the pressurizing chamber, the droplets of the fluid are discharged from the nozzle hole.

Besides the above constitution, the ink jet system head 2x is possible to have a head constitution by a cell system such that the droplets are discharged by heating a fluid by a heating element and expanding the fluid. However, the constitution is contingent on no deterioration of the fluid 1x due to heat or the like.

Tanks 31 to 3n are constituted to store respectively the fluid 11 to 1n, and to be able to supply respective fluid 11 to 1n to the ink jet system heads 21 to 2n through pipes. Of course, if the resist material is limited to one kind, a plurality of tanks, ink jet system heads, and fluid are not required.

A transferring device 4 comprises motors 41 and 42, and a rotating motion-to-horizontal motion conversion mechanism which is not shown in the drawing. The motor 41 is constituted to be able to transfer the ink jet system head 2x in an X axis direction (the horizontal direction of Fig. 1)

corresponding to a driving signal Sx. The motor M2 is constituted to be able to transfer the ink jet system head 2x in a Y axis direction (the perspective direction of Fig. 1) corresponding to a driving signal Sy. It is possible to provide a motor and a mechanism for transferring the head in up and down directions, namely in a Z axis direction. In addition, the transferring device 4 is needed only to have a constitution to be able to vary relatively the position of the ink jet system head 2x to the substrate 1. Accordingly, besides the above constitution, it is possible to provide a constitution for shifting a setting stand for a substrate so that relative movement of the substrate 1 to the ink jet system head 2x is caused, or a constitution for shifting the ink jet system head 2x and the substrate 1 together.

The control circuit 5, for example, comprises a CPU which is a computer device, a memory, an interface circuit, and the like which are not shown in the drawing. The control circuit 5 is constituted to allow the pattern manufacturing apparatus performs a pattern manufacturing method of the present invention by running the predetermined program. Namely, it is constituted to be able to supply discharging signals Sh1 to Shn to any one of the ink jet system heads 21 to 2n in the case of discharging the droplet 10 of the fluid, and to supply driving signals Sx or Sy to the motors 41 or 42 in the case of shifting the head. Furthermore, pattern position information which is data for designating to form a pattern is stored in the memory of the control circuit 5. This information is input by users or analyzed and generated by reading a pattern diagram with a scanner or the like.

In addition, in the case that a solidification process is performed to the droplet 10 of the fluid from the ink jet system head 2x simultaneously with the fluid coating, a solidification device 6 can be further provided. The solidification device 6 is constituted to be able to perform a physical, physical chemical, or chemical treatment to the droplet 10 or a pattern forming face 100 corresponding to a control signal Sp which is supplied from the control circuit 5. For example, it is constituted to be able to perform a heating or drying process by spray of hot air, the laser irradiation or the lamp irradiation, and a chemical change treatment by adding the chemical substance.

(Manufacturing Method) Next, a pattern manufacturing method of the present embodiment mode is explained with reference to Fig. 3 to Fig. 7. In each figure, (a) is a cross sectional view of a manufacturing process of a substrate over which a pattern is formed, and (b) is a plane view of a substrate which is seen from the top of a pattern forming face. An example of the case that a transparent electrode film is formed over a glass substrate is shown in the following explanation. Such the substrate is used frequently in a display panel for instance. As shown in Fig. 3 to Fig. 7, the pattern manufacturing method of the present embodiment mode is constituted by a layer-to-be-etched forming process, a fluid coating process, a solidification process, an etching process, and a removing process.

The layer-to-be-etched forming process (Fig. 3): The layer-to-be-etched forming process is a process for forming a transparent electrode layer 101 to be a layer-to-be-etched layer and the like over the substrate 1. The substrate

1 has a mechanical strength and a light transmission property, and is stable physically and chemically, for example, is made by cutting glass or quartz into a predetermined shape. The transparent electrode film 101 is to be an electrode for supplying an electric field to a liquid crystal and the like. Materials having conductivity and a light transmission property are used for a transparent electrode such as ITO or MESA. Various kinds of coating methods are used for forming the transparent electrode layer 101 such as a spinner method, a spray method, a roll coater method, or a dye coat method. This process is treated with a coating apparatus which is different from the pattern manufacturing apparatus of the present invention.

The fluid coating process (Fig. 4): The fluid coating process is relating to the present invention, and is a process for coating the fluid 11 to 1n in which a resist material is dissolved in a solvent over the pattern forming face 100 of the transparent electrode film 101 by an ink jet system. The concrete treating is shown in a flow chart of Fig. 2.

First, a user inputs conditions to the control circuit 5 with the input device (S1). The control circuit 5 selects the fluid (10) which is fitted to the input conditions, and specifies the ink jet system head 2 to which this fluid 10 is supplied. Of course, the user can select any one of the fluid 11 to 1n by manual operation. It is important that the resist material is selected so that the resist pattern is not destroyed under the etching conditions or by the etchant which is used in the etching process (Fig. 6).

Next, the user designates deposited quantity of the fluid to the control

circuit 5 with the input device (S2). For example, it is designated by a thickness of the resist layer to be formed. The control circuit 5 decides the discharging signal Sh to supply to the ink jet system head 2 or the driving signals Sx and Sy to supply to the transferring device 4 in accordance with the designation of the deposited quantity. Namely, a quantity of the droplet of the fluid 10 which is discharged per one time from the ink jet system head 2, the number of times of discharge of the droplet per unit area, and a pitch between the droplets of the fluid over the pattern forming face are decided so that the fluid is deposited with the deposited quantity which is designated by the user. The quantity of droplet of the fluid which is discharged per one time can be controlled by a voltage of the discharging signal Sh added to the ink jet system memory 2 head in the case that a piezoelectric element has voltage dependence on voltage change for instance. The number of times of discharge of the droplets per unit area is decided by a correlation between the transferring speed of the ink jet system head 2 and the fluid discharging frequency from the ink jet system head 2. The pitch between the droplets of the fluid over the pattern forming face is decided by the same relation.

Subsequently, the control circuit 5 makes the fluid deposit into a pattern shape with the designated quantity with reference to pattern position information (S3 to S10). The pattern position information is that a start point, a target point and an end point of the pattern are set as a set of coordinate values per pattern as shown in Fig. 8. A first pattern P1 shown in Fig. 8 (a) is a series of line segments, and targets P10 to P15 are set at tops of

the segments. When the pattern is formed, the control circuit 5 makes the ink jet system head 2 transfer along the line segment from one target point to the next target point, while it makes the fluid discharge along the segment. Furthermore, in reference to a curve pattern, as pattern position information, the curve is divided into a set of short line segments, so that target points are set at the tops of them. For example, in a curve pattern P2 shown in Fig. 8 (b), target points P20 to P27 are set so as to form a pattern almost along the curve. Moreover, target points P30 to P43 are set so that the fluid is coated over the entire face of an area pattern P3 shown in Fig. 8 (c) by making the head reciprocate in the area pattern P3.

The control circuit 5 reads start point position information based on the above pattern position information, and makes the ink jet system head 2 transfer over the start point position (S3). Subsequently, the next target point is read (S4), and the fluid is started to discharge with the discharging frequency of the droplet 10 which is set or decided (S5). And then, the ink jet system head 2 is started to transfer (S6). The ink jet system head 2 is continued to transfer (S6) unless it reaches the target coordinate (S7: NO). When it reaches the target coordinate (S7: YES), it is decided whether the next target point is further set, namely the pattern ends or not (S9). As far as the pattern continues (S9: NO), the fluid 10 is continued to discharge and the head is continued to transfer (S4 to S7). When the pattern ends, it is checked whether there is any pattern or not over which the fluid should be deposited (S10). If there is another pattern (S10: YES), the pattern is formed (S3 to

S9).

A resist pattern 102 over which a proper quantity of the fluid 10 is deposited is formed over the pattern forming face 100 by the above treatments. Four patterns in all are formed in Fig. 4 (b). In the case of a nonlinear pattern or a wide pattern, the pattern is formed to have the desired width by reciprocating the ink jet system head 2 repeatedly.

The solidification process (Fig. 5): The solidification process is a process for solidifying the resist pattern 102 which is formed over the pattern forming face 100. The resist pattern 102 is heated by supplying the control signal Sp to the solidification device 6 from the control circuit 5 for instance. The object of the solidification treatment is to improve adhesion to the pattern forming face by evaporating the solvent component. Usually the heating treatment is general. It is not required that the treatment is separated to the pre-baking (pre-drying) and the post-baking conventionally, and the adhesive properties can be improved by evaporating the solvent components at once. When the heating treatment is performed, a laser beam with high energy such as an excimer laser or an excimer lamp is emitted. Furthermore, it is possible to heat by supplying infrared rays or an electromagnetic wave such as a microwave. Moreover, the substrate is taken out from this pattern manufacturing apparatus, and it can be heated directly in the electric furnace and the like. A chemical treatment can be applied to the solidification treatment besides the heating treatment, namely, the treatment that a compound causing a chemical reaction with a resist material is deposited to be

stacked in a pattern by an ink jet system and a solid compound is separated out to form a pattern. In addition, the solidification treatment can be performed by emitting a laser beam in order over the resist pattern which had been already deposited simultaneously with depositing the fluid. Due to the above solidification treatment, the resist pattern 102 over which the resist material is solidified is formed. The pattern is not collapsed after this treatment, even if the substrate 1 is inclined.

The etching treatment (Fig. 6): An etching process is a process for etching a layer-to-be-etched 101 to be a resist pattern shape by etching via a resist pattern 102. The etching method known publicly such as a wet etching or a dry etching is applied corresponding to a material of the layer-to-be etched. For example, when a transparent electrode is etched, the etchant such as hydrogen fluoride is used. The transparent electrode film 101 is removed according to the resist pattern 102 by this etching process.

The removing process (Fig. 7): A removing process is a process for removing a resist pattern which becomes needless from a substrate after etching. Since the resist pattern 102 becomes needless after etching, the resist pattern is removed by the solvent which dissolves the resist material. For example the resist pattern is released by being dipped in a release agent heated to from 120°C to 130°C containing mainly phenol and an organic solvent of halogen system, or the strong acid such as hot concentrated sulfuric acid, fuming nitric acid, or sulfuric acid-hydrogen peroxide.

According to the present embodiment mode mentioned above, since the

resist material can be provided locally by the ink jet system, the resist material is hardly wasted. Furthermore, since the deposited quantity of the resist material can be controlled per droplet, the resist material is not used in surplus. Moreover, since the resist material is not required having photosensitivity, it is possible to use the material which can not be used as the resist material conventionally.

(Other examples of Variation) The present invention can be applied not only to the above embodiment mode, but also to the variations. For example, the transparent electrode film is patterned over the substrate such as glass in the above process. However, without sticking this, the present invention can be applied to every pattern formation which is formed conventionally by lithography. For instance, a semiconductor such as an assembly substrate, IC or LSI can be formed with small equipment at low manufacturing cost and without the complicated process control by applying the present invention to patterning of a semiconductor circuit or a substrate for setting a discrete part. Furthermore, a pattern which is formed over a pattern forming face is not limited to an electric circuit, but it can be formed over a pattern forming face with mechanical or designed object. This is why the advantage of the ink jet system that the microscopic pattern can be formed easily with low-priced equipment can be obtained as it is. For example, it can be applied to letter formation with a particular material which is performed by a printing apparatus conventionally.

Furthermore, a surface modified treatment can be performed over a

pattern forming face in advance before the fluid is discharged by the ink jet system. The adhesive properties of the fluid are improved by the surface treatment. For example, as the surface modified treatment for giving affinity to a pattern forming face, the various methods known publicly are applied corresponding to the existence of a polar molecular of the fluid such as a method of coating silane coupling agent, a method of reverse sputtering with argon and the like, a corona discharging treatment, a plasma treatment, an ultraviolet rays irradiating treatment, an ozone treatment, or a degreasing treatment. In the case that the fluid does not contain the polar molecular, the various methods known publicly can be applied such as the method of coating silane coupling agent, a method of forming a porous film such as aluminum-oxide or silica, a method of reverse sputtering with argon and the like, a corona discharging treatment, a plasma treatment, an ultraviolet rays irradiating treatment, an ozone treatment, or a degreasing treatment.

[Advantageous effects of the invention]

According to the present invention, since a process for providing resist locally is prepared, a resist material is not wasted and the number of processes is reduced sharply compared with the case using a lithography method, and consequently the manufacturing cost can be reduced.

According to the present invention, since a selection for adjusting a thickness of resist is presented, it can be designed to reduce the waste of the resist material and the number of processes due to thinking the most suitable

method among these methods, and consequently the manufacturing cost can be reduced.

According to the present invention, since the conditions of the fluid for providing resist locally are presented, it is possible to use resist as the resist as long as it satisfies these conditions, and consequently the limitation of resist selection can be enlarged.

According to the present invention, the scope for selecting resist in users can be enlarged by presenting concretely the constituent for providing a resist locally.

According to the present invention, since a manufacturing apparatus for providing resist locally is presented, when the resist is formed by using this apparatus, it can be designed to reduce the waste of the resist material and the number of processes, and consequently the manufacturing cost can be reduced.

[Brief Description of the Drawings]

Fig. 1 is a block diagram of a pattern manufacturing apparatus in an embodiment mode of the present invention.

Fig. 2 is a flow chart explaining a pattern manufacturing method in an embodiment.

Fig. 3 is an explanatory view of a process for forming a layer-to-be-etched in which (a) is a cross sectional view of a substrate, (b) is a plane view of a substrate.

Fig. 4 is an explanatory view of a process for depositing a fluid in which (a) is a cross sectional view of a substrate, (b) is a plane view of a substrate.

Fig. 5 is an explanatory view of a process for solidifying in which (a) is a cross sectional view of a substrate, (b) is a plane view of a substrate. A discharging process in the case of using a fluid containing microparticles.

Fig. 6 is an explanatory view of a process for etching in which (a) is a cross sectional view of a substrate, (b) is a plane view of a substrate. A heating process in the case of using a fluid containing microparticles.

Fig. 7 is an explanatory view of a process for removing in which (a) is a cross sectional view of a substrate, (b) is a plane view of a substrate. An adhesive film forming process in the case of using an adhesive agent.

Fig. 8 is an explanatory view of pattern position information.

[Description of the Reference Numerals and Signs]

1 ... substrate

2, 2x, 21 to 2n ... ink jet system head

3, 3x, 31 to 3n ... treating device

4 ... transferring device

5 ... control circuit

6 ...solidification apparatus

1, 1x, 11 to 1n ... fluid (pattern forming material)

100 ... pattern forming face

101 ... transparent electrode film

102 ... resist pattern